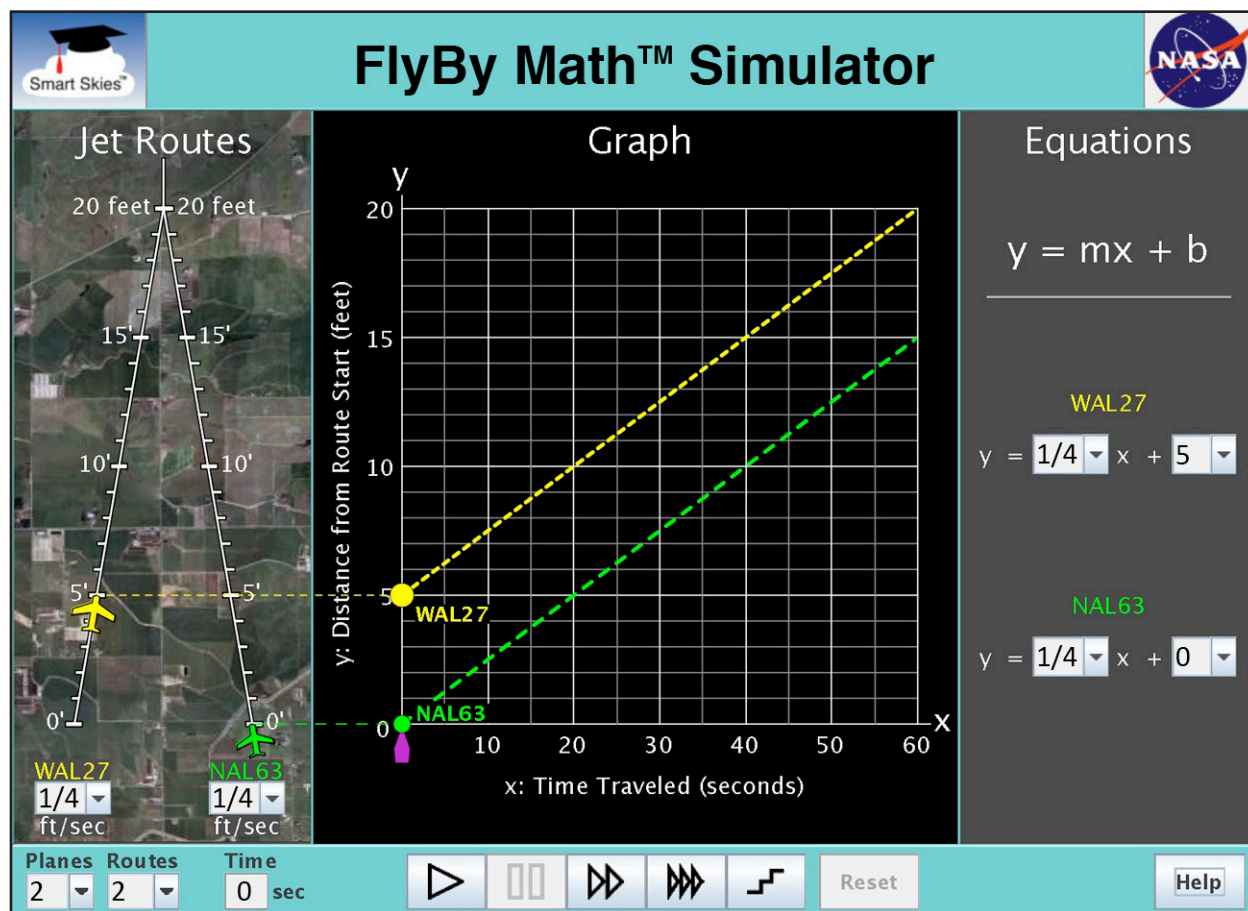


**Student Worksheet D****Analyzing Headstart: Two Planes Flying at the Same Speed**

In this worksheet, you will work with 2 planes and 2 jet routes.

- Each jet route is 20 feet long.
- The jet routes meet at the 20-foot mark.
- The planes are flying at the same altitude.
- The planes are flying at the same speed.
- One plane has a HEADSTART. That is, at time zero, one plane is closer to the point where the jet routes meet. That plane has a LEAD.



You will use the simulator to learn:

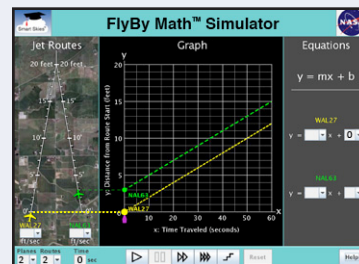
- How to find a plane's headstart using the **Jet Route Panel**, the **Graph Panel**, and the **Equation Panel**.
- What happens to this headstart as both planes fly at the same speed.



## Exploring the Simulator

### Problem 1: Set up the simulator

- Time slider: 0 seconds
- 2 planes, 2 routes
- WAL27 starting position: 0 ft
- NAL63 starting position: Choose any position from 1 ft to 10 ft.
- WAL27 speed: Choose any speed greater than 0 ft/sec.
- NAL63 speed: Choose the same speed as for WAL27.



(a) What NAL63 starting position did you choose?

\_\_\_\_\_ ft

(b) NAL63 is closer than WAL27 to the point where the jet routes meet.

So NAL63 has a HEADSTART. What is the NAL63 headstart?

\_\_\_\_\_ ft



(c) What WAL27 speed did you choose?

\_\_\_\_\_ ft/sec

What NAL63 speed did you choose?

\_\_\_\_\_ ft/sec

**Remember:** The *speeds* should be the *SAME*.

(d) Run the problem until it stops.



In the **Jet Route Panel**, notice that NAL63 is still ahead of WAL27.

What is the NAL63 lead? (How far ahead is NAL63?)

\_\_\_\_\_ ft

True or False:

This lead is the same as the NAL63 headstart.

True      False



In the **Graph Panel**, notice the lines. Put a **T** next to all TRUE statements below:

\_\_\_\_\_ The lines cross.

\_\_\_\_\_ The lines are parallel.

\_\_\_\_\_ The vertical (  $\updownarrow$  ) distance between the lines does not change.



(e) In the **Equation Panel**, notice that the lines have the *same* slope ( $m$ ). So the lines in the **Graph Panel** are *parallel*. What did you do in the **Jet Route Panel** that made the slopes the same?

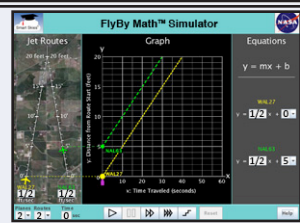
\_\_\_\_\_



## Collecting and Analyzing Headstart Data

### Problem 2: Set up the simulator

- Time slider: 0 seconds
- WAL27 start: 0 feet,  $\frac{1}{2}$  ft/sec
- 2 planes, 2 routes
- NAL63 start: 5 feet,  $\frac{1}{2}$  ft/sec



(a) In the **Jet Route Panel**, what is the NAL63 headstart at time zero (0 seconds)?

\_\_\_\_\_ ft



(b) In the **Graph Panel**, how far apart are the dots on the y-axis?

\_\_\_\_\_ ft



(c) Run the problem until it stops at 30 seconds. In the **Jet Route Panel**,

Where is NAL63?

\_\_\_\_\_ ft

Where is WAL27?

\_\_\_\_\_ ft

What is the NAL63 lead? (How far ahead is NAL63?)

\_\_\_\_\_ ft



(d) In the **Graph Panel**, at  $x = 30$  seconds, what is the **y-coordinate** for each dot (•)?

NAL63 dot:  $(x, y) = (30 \text{ seconds}, \text{_____ ft})$

WAL27 dot:  $(x, y) = (30 \text{ seconds}, \text{_____ ft})$

(e) Subtract the y-coordinates. What is the difference between the NAL63 y-coordinate and the WAL27 y-coordinate?

\_\_\_\_\_ ft

(f) What is the vertical ( $\updownarrow$ ) distance between the parallel lines?

\_\_\_\_\_ ft



(g) In the **Equation Panel**:

What is the value of b (the y-intercept) for the **NAL63** equation?

b = \_\_\_\_\_ ft

What is the value of b (the y-intercept) for the **WAL27** equation?

b = \_\_\_\_\_ ft

Subtract those values. What is the difference between the NAL63 and the WAL27 y-intercepts?

\_\_\_\_\_ ft

(h) Circle all the items below that are equal to 5 feet:

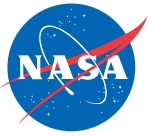
NAL63 headstart at 0 seconds

Vertical distance between the parallel lines

NAL63 lead at 20 seconds

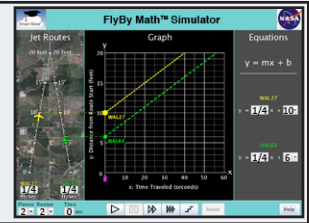
Difference between the y-intercepts

NAL63 lead at 30 seconds



### Problem 3: Set up the simulator

- Time slider: 0 seconds
- WAL27 start: 10 feet,  $\frac{1}{4}$  ft/sec
- 2 planes, 2 routes
- NAL63 start: 6 feet,  $\frac{1}{4}$  ft/sec



(a) In the **Jet Route Panel**, what is the WAL27 headstart at time zero (0 seconds)?

\_\_\_\_\_ ft



(b) In the **Graph Panel**, how far apart are the dots on the y-axis?

\_\_\_\_\_ ft



(c) Run the problem until it stops at 40 seconds. In the **Jet Route Panel**,

Where is WAL27?

\_\_\_\_\_ ft

Where is NAL63?

\_\_\_\_\_ ft

What is the WAL27 lead? (How far ahead is WAL27?)

\_\_\_\_\_ ft



(d) In the **Graph Panel**, at  $x = 40$  seconds, what is the **y-coordinate** for each dot (•)?

WAL27 dot:  $(x, y) = (40 \text{ seconds}, \text{_____ ft})$

NAL63 dot:  $(x, y) = (40 \text{ seconds}, \text{_____ ft})$

(e) Subtract the y-coordinates. What is the difference between the WAL27 y-coordinate and the NAL63 y-coordinate?

\_\_\_\_\_ ft

(f) What is the vertical ( $\updownarrow$ ) distance between the parallel lines?

\_\_\_\_\_ ft



(g) In the **Equation Panel**:

What is the value of b (the y-intercept) for the **WAL27** equation?

b = \_\_\_\_\_ ft

What is the value of b (the y-intercept) for the **NAL63** equation?

b = \_\_\_\_\_ ft

Subtract those values. What is the difference between the WAL27 and the NAL63 y-intercepts?

\_\_\_\_\_ ft

(h) Circle all the items below that are equal to 4 feet:

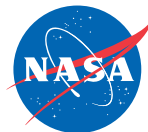
WAL27 headstart at 0 seconds

Vertical distance between the parallel lines

WAL27 lead at 20 seconds

Difference between the y-intercepts

WAL27 lead at 40 seconds



## Summarizing Headstart

### Problem 4:

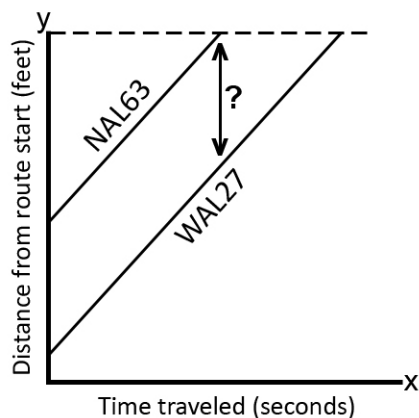
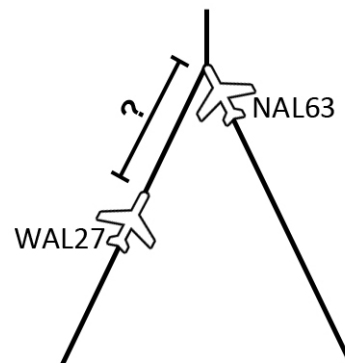
- WAL27 and NAL63 are flying on their jet routes at the **same speed**.
- WAL27 and NAL63 are flying at the same altitude.
- NAL63 has a headstart.

To answer the following questions, use what you learned in Problems 1 through 3.

- (a) If you know the NAL63 headstart, do you also know the distance between the planes when NAL63 reaches the point where the jet routes meet?    Yes    No

Why or why not? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_



- (b) If you know the NAL63 headstart, do you also know the vertical (  $\updownarrow$  ) distance between the parallel lines on the graph?    Yes    No

Why or why not? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

- (c) If WAL27 starts at 2 ft and NAL63 starts at 9 ft, their equations might look like this:

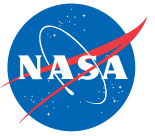
Which plane has a headstart? \_\_\_\_\_

What is the headstart? \_\_\_\_\_ ft

How do you know? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

$$\begin{array}{l} \text{WAL27} \\ y = 0.6x + 2 \\ \\ \text{NAL63} \\ y = 0.6x + 9 \end{array}$$



**Problem 5:**

- Two planes are flying at the same speed.
- One plane has a headstart.

(a) SUMMARIZE: Choose the word or phrase that best completes the sentence.

Unless one plane changes its speed, the lead will:

- ☐ increase
- ☐ stay the same
- ☐ decrease

(b) GO BEYOND: If the two planes are **not** flying at the same speed, will the lead stay the same?

Yes      No

Why or why not? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_